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# Surge activities on November 26-28, 1990

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**Abstract.** We report here a study of 8 solar surges observed in $H_\alpha$ emission on the west solar limb (active region NOAA 6368) on 26, 27 and 28 November 1990. Three surges were observed on 26 November of durations 35, 86 and 40 min at the time intervals of 20 and 25 min respectively for successive events. Again in the same active region, we have observed two solar surges of durations 56 and 101 min on 27 November at an interval of 10 min. Three surges were also observed on 28 November of durations 25, 138 and 95 mins at the time intervals of 10 and 20 min respectively for successive events. Using photographic observations, we have studied the morphological behaviour and estimated the height, mass, radial velocity, mechanical energies and magnetic fields associated with the 8 surges. The x-ray and radio data observed during the surges are also included in the study. The various parameters estimated from the observed data are discussed in light of solar surge theories.

*Key words* : solar activity - surge prominence - homologous surges - recurrent activity

## 1. Observations and analysis

While monitoring the sun through the 15-cm coude refractor and Day Star $H_\alpha$ filter (pass band) 0.5 Å on three days i.e. 26, 27 and 28 November 1990 we have observed 8 surges on the west limb near the active region NOAA 6368. The active region NOAA 6368 was very rich in surges as well as flare activity as seen from the Solar Geophysical Data (SGD) 1991. We have estimated the mass and mechanical energy, (i.e. the sun of the kinetic energy and the potential energy) for the surges of 26, 27 and 28 November 1990 which are shown in Table 1. For estimating the mass, the plasma column was idealised as a uniform cylindrical column and followed, method of Verma (1983). In estimating mass and mechanical energy, we assumed that the plasma density remains the same throughout the surge. Mechanical energy estimated at the time when surges velocities are maximum.

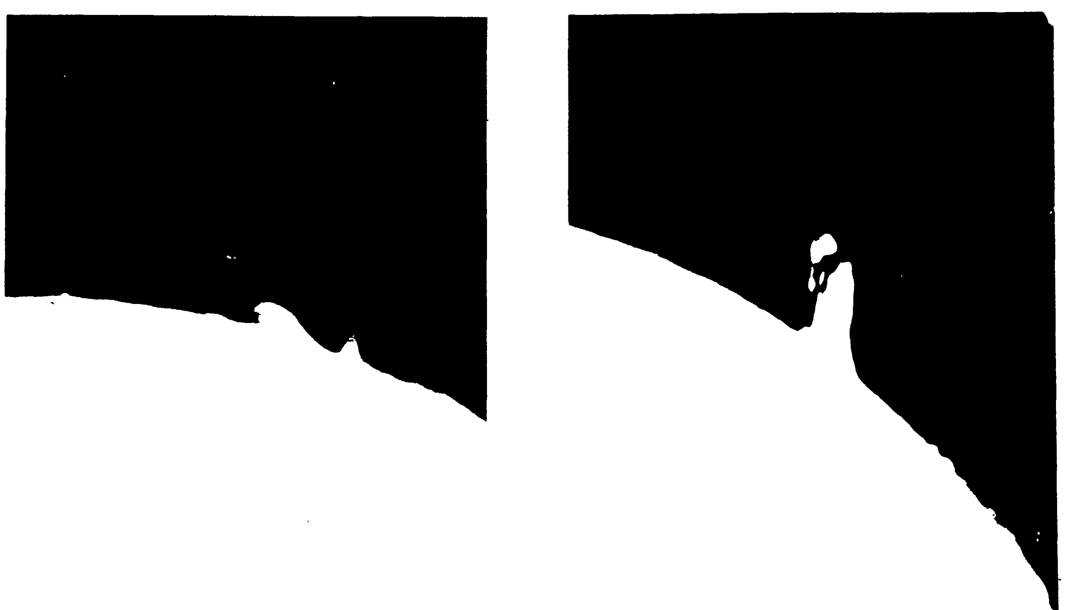
By using temporal correlations we found that four surges (S2, S4, S5 and S6) are associated with radio, microwave, soft x-ray bursts and SIDs as seen (SGD, 1991). We have estimated height, velocity, mass, kinetic energy for all 8 surges observed on 26, 27 and 28 November 1990 as shown in Table 1.

## 2. Result and discussions

The ascending phase for most of the surges is the characteristic phase at which the solar surges rush out from the sun. The accelerations obtained for the surges in the present study ranges from 0.034 to 3.2 km/s$^2$. Small surges are accelerated with a slower rate as compared to the large surges (cf. Table 1). The S5 and S7 are very complex surges with multiflux tubes and have many bright knots, visible in the surge column. These are major surges observed by us. They show surge cum spray characteristics. We have estimated its maximum acceleration as 2.6 km/s$^2$ which is about 9 times of solar gravity and the mechanical energy $2.68 \times 10^{32}$ ergs which is very high for the surge activity (cf., Table 1.). The surges S5 and S7 appear to be very dynamic and represents rare events. The dynamic phase of Surges S5 and S7 has been shown in Figure 1a and 1b. All surges have a common source of origin and recurring tendency. These surges seem to be homologus surges according to the shape, inclination (about 70°), common place of origin and other characteristics.

Using time correlation method Type III radio burst of 2 min duration at 03 25 UT and microwave spike of 1 min duration at 03 12 UT can be correlated very well with the surge S2 (SGD 1991).

We found that during the surge S4, type III radio burst of 2 min soft X-ray burst of importance class C2 of 11 min duration and SIDs of 23 min occurred which show association with this surge (SGD 1991).



1a(27 Nov. 1990)
04 35 56 UT

1b(28 Nov. 1990)
04 00 17 UT

**Figure 1a and 1b.** Show dynamic phase of surges S5 and S7

In the case of the Surge 5 at the maximum phase, long duration microwave bursts of high importance class i.e. 42-46 and soft X-ray burst of M 1.5 importance class have been found to be associated. SIDs also occurred during this surge. Further, two type III radio bursts of 2 min and 10 min durations occurred respectively at 03 37 UT and 03 49 UT during the fast rising phase of the Surge 7 and a soft X-ray burst of importance class C2.1 (duration 33 min) occurred during the maximum phase. During the maximum phase, SIDs of about 85 min duration have also been observed showing an association with S7 (SGD 1991).

From our analysis it is clear that all the surges studied are energetic and some of these are associated with the type III microwave, X-ray bursts and SIDs showing dynamic behaviour from photosphere to control and interplanetary regions (cf., Table 1). Though the surges studied by us have different dimensions and other parameters, but the general characteristics of these surges show that almost similar mechanisms are working in all of them, therefore we conclude that these surges may be homologus surges.

According to Schmieder et. al. (1993) the active region which produced good number of solar surges during its evolution, does not produce large flares. In our case the active region NOAA 6368 during transition of solar disk between 12th - 27th November produced this active

**Table 1.**

| S. No. | Max height $\times 10^3$ km | Max velocity in ascending phase | Max velocity in descending phase | Duration min | Class | Acclr. km/s$^2$ | mass(gm) $\times 10^{15}$ | Mech. Energy $\times 10^{30}$ (ergs) |
|---|---|---|---|---|---|---|---|---|
| Surge 1 | 60 | 281 | 216<br>181* | 24 | 1 | 1.23 | 2.63 | 1.40 |
| Surge 2 | 52 | 102 | 141<br>168* | 86 | 1 | 0.933 | 2.73 | 0.441 |
| Surge 3 | 50 | 35 | 74<br>165* | 40.2 | 1 | 0.034 | -- | -- |
| Surge 4 | 69 | 208 | 68<br>193* | 56.5 | 1 | 0.32 | 22.6 | 7.85 |
| Surge 5 | 112 | 223 | 170<br>248* | 100.9 | 2 | 3.2 | 94.3 | 66.5 |
| Surge 6 | 55 | 81 | 213<br>172* | 28.5 | 1 | 0.32 | 2.86 | 4.55 |
| Surge 7 | 199 | 207 | 127<br>330* | 140 | 3 | 2.55 | 375 | 268 |
| Surge 8 | 47 | 37 | 20<br>160* | 86 | 1 | 0.225 | -- | -- |

* denote the free fall velocity of the respective surge

region produced about 186 $H_{\alpha}$ flares, most of them are sub-class faint flares and about 67 surges like events. Since active region NOAA 6368 produced about 186 small flares and about 67 surges therefore the energy flux could not build to a high enough value to produce large flares. Further, the active region NOAA 6368 produced about 186 flares and about 67 surges and could not produce a single large flare confirms model of Schmieder et al. (1993). The formation of surges are recently explained by Kurokawa and Kawai (1993) on the basis of reconnection model of EFR (Emerging flux region) surges, which is based on reconnection between pre existing magnetic flux and fluxes of EFR.

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